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FINAL TECHNICAL REPORT IN SUPPORT OF TECHNICAL DEVELOPMENT PLAN 43-03X EDUCATION AND TRAINING

November 15, 1976

ROWLAND & COMPANY, INC.
NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY
Pensacola, Florida

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CHIEF OF NAVAL AIR TRAINING COMMAND

and for the

NAVAL AEROSPACE MEDICAL RESEARCH LABORATORY

under sponsorship of

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This is the final technical report on a five-phase program to develop a Data Management System and a Student Management System. This report reviews the program objectives, program plans, products developed, and summarizes subject-areas for significant findings or developments. These ~~latter~~ findings pertain to the naval air training system features that impact on the enhancement of individualized student pilot training treatment and on student training success prediction capabilities and options. → next page

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The Data Management System (DMS) was designed and implemented on to a Nova 800 minicomputer to demonstrate the feasibility of operation. This DMS is a user-oriented online system which permits non-programmer or non-computer type personnel to create data base files, update these files, search single or multiple files, and to secure hard copy printouts of search results. A unique feature is provided which permits users to execute certain descriptive and analytic statistics on records located by the search. Users are assisted in operation of the DMS by a wide array of man-computer dialog. This dialog is in non-technical conversational language. The DMS is capable of being implemented and operated in a wide range of military or government installations where the need exists for turnkey type information management systems.

The Student Management System consists of a description and specification of the concept, products and records required to enhance an individualized student naval pilot training treatment program. This system uses existing data available within the current student records and training syllabus on which to base the individualized treatment. The heart of the system is the use of products which more quantitatively reflect a student's proficiency status -- weak, strong, and average performance areas. These student profiles form the quantitative bases from which administrative training personnel can select individualized treatment options.

References to past reports are made to guide the reader to those which treat the above topics in more detail.

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SECTION I

INTRODUCTION

This report is the final technical report of a five-phase development program. Phase I began on May 16, 1972, and Phase V was completed on November 15, 1976.

The program objectives were to develop a Data Management System (DMS), and a Student Management System (SMS). The development program began under Advanced Development Objective 43-3, Human Factors Technology, and was shifted to Technical Development Plan 43-03X, Education and Training. The initial development agent was the Naval Air Systems Command; it was later transferred to the Navy Personnel Research and Development Center. Throughout the total development program, the contracting agent was the Personnel and Training Research Programs, Psychology Division, Office of Naval Research. The development effort was performed on-site at the Naval Aerospace Medical Research Laboratory, Pensacola, Florida. The on-site technical monitors were CDR T. Gallagher, LCDR N. Lane and LCDR R. Doll.

The program was executed by Rowland & Company, Inc., Haddonfield, New Jersey. Dr. George Rowland served as the principal investigator. Mr. Edward Marlowe served as the project director throughout the development period. Mr. Carlos Escobar served as the computer system analyst and was responsible for the design and implementation of the DMS. Various other Rowland & Company personnel provided valuable support to the results achieved.

SECTION II

PROGRAM OBJECTIVES

The objectives of this development program were twofold: the first was the development/demonstration of a prototype Data Management System that could operate on a minicomputer; the second was the development of a specification for a Student Management System.

The Data Management System was to provide for a high degree of automation associated with the data entry, storage, retrieval and analysis of large volumes of data for student naval aviator and student naval flight officers. This system would overcome many of the limitations of the current manual and batch-oriented data processing system. The DMS would be used to handle student selection test scores, academic and flight training performance data and other experimentally derived test data on student aptitude capabilities.

Such a system would benefit the Aerospace Medical Research Laboratory, which has a support role to the Bureau of Medicine and Surgery, in development of selection tests and criteria used for screening candidates who apply for training. The Laboratory also has a support role to the Chief of Naval Air Training. This second role is to provide predictions on students who are having difficulty in the training programs. These predictions provide a quantitative score which is an estimate of the student's chances of completing the total training program successfully. The DMS would provide support to the continued research associated with these predictions and with its continued daily operation.

The Student Management System is intended to provide the concepts, procedures and information by which students could be given greater individualized training treatments. To individualize training treatments, it is first necessary to differentiate between students. The student Management System concentrated on those differences that existed in the flight performance domain. A knowledge of the strong, medium and weak flight maneuvers of students at all positions in the total flight syllabus was to be the major emphasis. Flight Instructors and Training Officers would use this knowledge to adjust the student's training flight hop content or their instructional techniques to improve the weak areas and to spend less time on the students' strong maneuvers.

Concurrent with the scheduled development of the DMS and SMS was the planned development of the Naval Aviation Training Information System (NATIS). Two modules within the planned NATIS were the Database Module and the individualized Pilot Training Subsystem. The DMS was considered to be a viable option by which NATIS could fulfill the Database Module in the distribution network of NATIS. The SMS would fulfill many of the planned requirements of the Individualized Pilot Training Subsystem of NATIS (9, 10).

SECTION III

THE DEVELOPMENT PLAN

The development concept and task plan are presented in three successive figures.

The development concept is presented in Figure 3.1. At the top of the illustration is depicted six process elements in the selection and training of student naval aviators. Information on the students is available from each of these six elements. The plan called for the successive entry and analysis of information from the first five of these into an Experimental Data Bank. Computer analyses of these student data was intended to provide an empirical basis for the development of the planned Student Management System and for the organization of the data files which were to be handled by the planned Data Management System. Many of the findings which are related to the Naval Pilot Training System were based on these empirical data and the information they yielded when subjected to computer analysis.

The task structure of the development program is illustrated in Figure 3.2. Three major tasks were defined and pursued as the means by which the development program objectives could be reached. The first two tasks parallel the two products to be developed. The third task covers all effort related to the operation of the Experimental Data Bank and other supporting tasks.

An expansion of each of these three task areas, together with a time-phased schedule for five phases, is illustrated in Figure 3.3. An examination of the tasks under each of the five phases will reveal the successive development of the two products and of the execution of supporting tasks which impact on the planned capabilities of the Student Management System and the Data Management System database file system and content. No attempt will be made to discuss each of the entries in detail since the idea of presenting this figure was to depict the existence of a comprehensive plan which supported the development program.

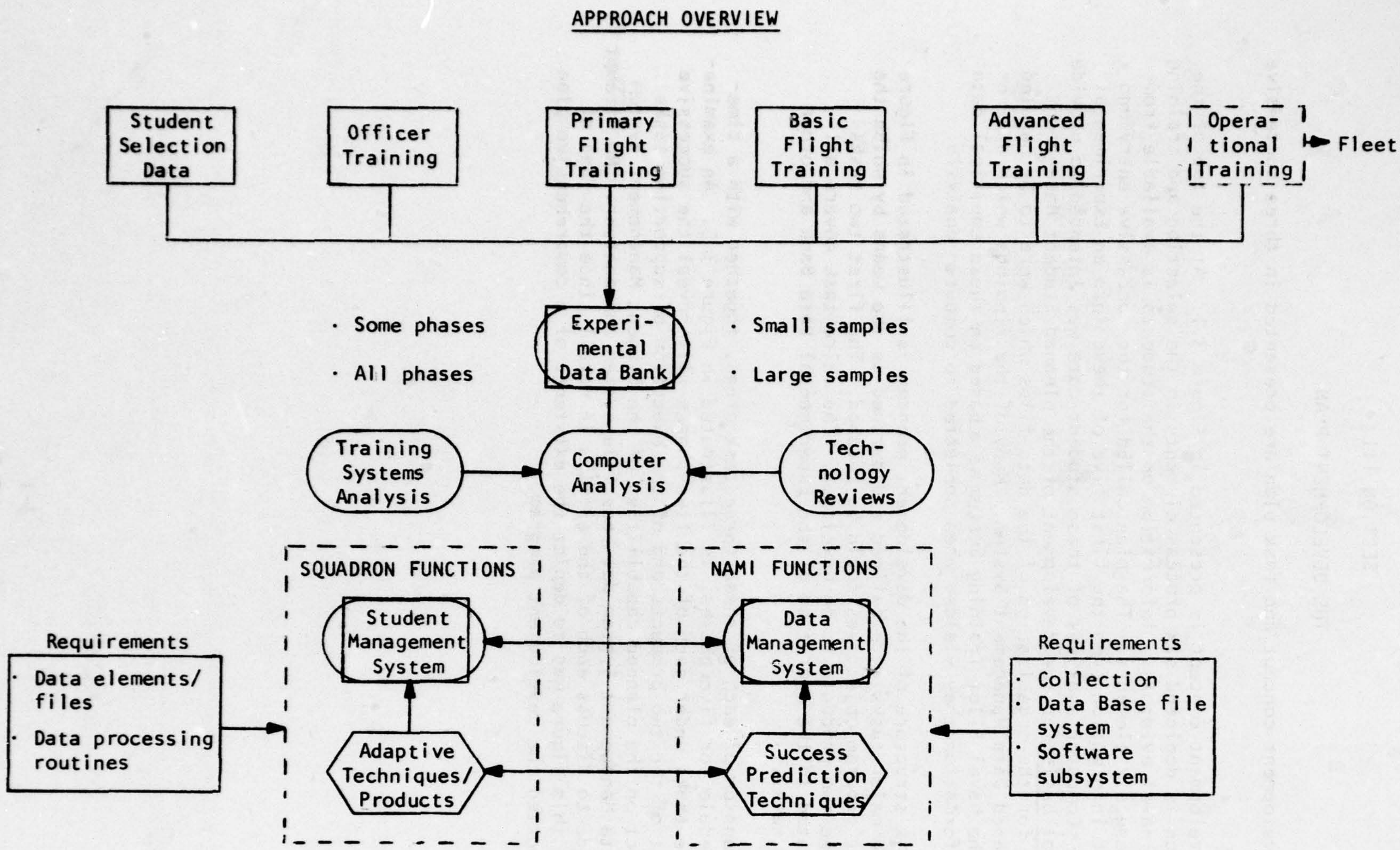

Figure 3.1. Development Concept

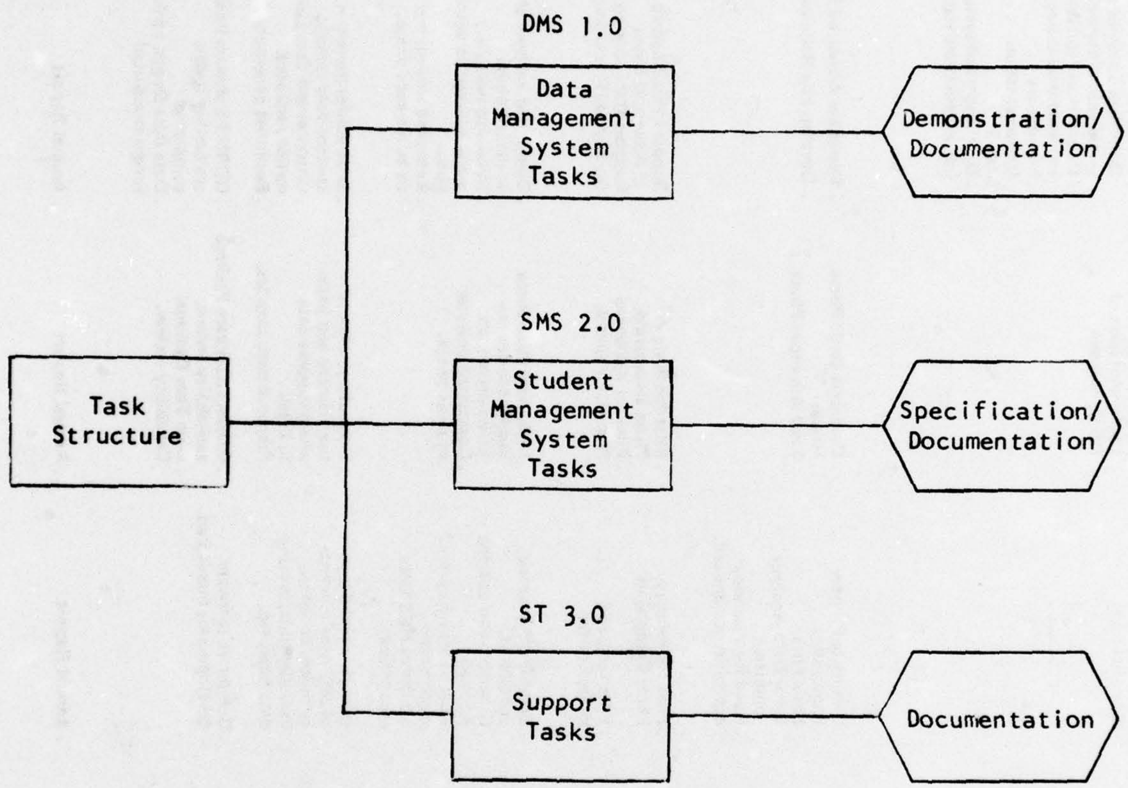

Figure 3.2. Program Task Organization and Outputs

Task Areas		Phases and Milestones: I	II	III	IV	V
1.0	Data Management System	. Design Concept Functional Spec	. Requirements Specifications	. Programming/ Implementation of DE Subsystem	. DMS-1: . Data Base Subsystem implementation/test . Data Processing/Retrieval implementation begun . Preliminary Documentation . DMS-2: . Data Entry Subsystem implementation/test.	DMS-1: . Data Processing/Retrieval Subsystem Completed . System Integration/test. . System Documentation DMS-2: . Data Base Subsystem implementation completed . Data Processing/Retrieval Subsystem Implemented. . DMS-2 Integration/test. . DMS-2 Documentation. . Train Data Base Administrator.
2.0	Student Management System	. Functional Concept/ Sample Products/ Primary Phase . Error Data Encoded . Adaptive Resources Options Identified . Student Quality Control Options Identified	. Complete Primary Phase; start Basic Phase . Error Data Analysis completed . Need for diagnosis capability recognized.	. Complete Basic Phase Phase; . Start Advanced Phase	. Complete Advanced Phase . Develop File Requirements	. Complete Specifications for SMS.
3.0	Support Tasks . Experimental Data Bank	. Tape Files Created . Small Sample Students Data encoded. . Files for Large Sample started (primary phase)	. Files for Primary Phase Completed . Files for Basic Phase Started	. Files for Basic Phase Completed . Files for Advanced Phase Completed.	. Support File Analysis of Advanced Phase . Support Data Manipulation for Success Prediction	. Support Processing of EDB student data. . Transfer EDB files to NOVA 800.
	. Training System Analysis	. Statistics on EDB contents . Grade Systems Features Identified . Adaptive techniques in use identified.	. Error Data Analysis completed. . Grade System options Applied . Role of 'down system' recognized. . Limits of NRS Data recognized.	. Individual differences in-flight hours statistics developed . Completed analysis of basic phase.	. Completed analysis of advanced phase. . Extended reliability grade concept to advance phase. . Extended throughput analysis to advance phase.	. Relation of student characteristics to throughput schedule. . Summarize results in final report.
	. Student Success Prediction	. Revealed that selection test sub-scores and selected stage maneuver grades provided new prediction options.	. Direction and Scope of SPS developments outlined; criterion, data elements, moving data base, etc.	. Formulated plan to use primary and basic phase student data in EDB. . Prepared data samples.	. Selection/preparation of student data sample. . Criterion and data element options selected. . Formulae generation.	. No tasks scheduled.
	. Technology Reviews	. Minicomputer Developments for DMS & SMS. . Data Base Concept Review. . Pilot Performance . Measurement Survey completed.	. Computer/software developments monitored.	. GDBMS Software Package availability review. . Data Base Optional Capability review.	. GDBMS Software Package availability review completed . Data Base Design option survey completed	. Review other ADO 43-03X documents
	. Documentation	. Annual Report	. Annual Report	. Annual Report	. Annual Report	. DMS-1 . DMS-2 . Data Base Administrator . Annual Report . Final Report

Figure 3.3. Task and Phase Summary

SECTION IV

DATA MANAGEMENT SYSTEM

INTRODUCTION

The plan for this product called for the successive execution of a series of steps in a planned development program.

An examination of the task and phase summary for the Data Management System in Figure 3.3 will reveal a progression from the formulation of the initial DMS design concept through several design steps and the final implementation and demonstration of its operation. The demonstrations were completed as per the phase schedule. The discussion below will review the progress and accomplishments made during each of these five phases.

PHASE I - Operational Concept

What kind of a system would provide the research-oriented personnel of the Psychology Department with a capability to rapidly access the large volume of student records maintained in its current and future student data banks? What kind of turn-around time did these personnel need in order to perform timely student selection research and to update the Student Success Prediction System? What kind of new data elements might this system store and make accessible in order to improve upon the selection of student candidates and upon the training success prediction of student naval aviators and of student naval flight officers? What kind of problems were present in the current system for handling the large volumes of student selection and training performance data? These were some of the concerns in the initial study phase. Also, how can this data handling system help the Chief of Naval Air Training to improve upon its management of students as they progress through their lengthy period of training?

The design concept which emerged was influenced by several technological and political factors that were present. The political factors were: (1) the system had to be able to handle not only the student data for the Psychology Department, but the system per se had to have some benefit to the Chief of Naval Air Training; (2) the system could not be placed on the current UNIVAC 418 computer because it was not programmed in a high level language and also the computer was an early generation computer; (3) the Psychology Department was in the process of obtaining minicomputers for their laboratory and these had to be considered; (4) there was interest on the part of the Navy Personnel Research and Training Laboratory that the final system have as much transportability to other Navy facilities as practical in order to maximize the benefit not only to the Psychology Department, but also to the Navy per se.

The technical factors saw the emergence of the minicomputer as a low-cost resource which used high level language (primarily FORTRAN). There was a development to make these minicomputers serve users more directly than large batch-oriented computers. Thus, user-oriented systems were emerging and these brought the full resources of the computers directly to the customer without having to deal with a cadre of data processing personnel in order to

'get things done.' These systems were sometimes called 'turn-key' because they could be placed into operation through very simple procedures. What was lacking with these minicomputers was the software programs needed to support the capability to handle the large volumes of student data which the Psychology Department needed to store, access and manipulate in complex combinations.

The design concept adopted was to implement a user-oriented system onto the minicomputers being secured by the Psychology Department. This user-oriented system would contain all of the software programs necessary to: (1) make the system usable by dedicated and casual users; (2) be able to handle the data manipulations required, but to achieve as high a degree of automation as practical so as to reduce the dependency upon programmer personnel. To keep the software from being outdated, it was decided to make it generalized; i.e., handle data manipulation needed to store records, to update these records frequently, and to make searches of the records so as to answer any type of operational or ad hoc questions of its contents. Such a system had to be independent of the specific applications; i.e., able to be used in a variety of operational settings and serve the needs of users in each setting. The operational concept which emerged is depicted in Figure 4.1.

The system depicted shows user personnel interacting directly with the system via a terminal display. The software system, termed a Data Management System, provides all of the computer programs necessary to support six types of user transactions. All of these six transactions are normal to the use of computer resources for the systematic entry and effective storage of data files with their frequent update to keep the contents current, and a search of the contents to retrieve records or to secure answers to information queries of the file contents. All of these transactions are executed with the aid of the man-computer interactive english language dialog. The dialog consists of instructions which guide the user into making desired keyboard entries necessary to the reliable completion of the transactions. A complete description of the Data Management System appears in references (6) and (8).

PHASE II - DMS Requirements Specifications

The design of the DMS provided for three subsystems. These are: (1) data entry subsystem; (2) data base subsystem; and (3) query/retrieval subsystem. The development of subsystem requirements specifications, the computer programs to meet these specifications, and the mechanization of these computer programs onto the NOVA 800 minicomputer were planned and followed for each of the three subsystems. During Phase II, the requirements were completed for the Data Entry Subsystem together with some of the programming specifications. No implementation onto the NOVA computer was made due to a delay in its actual arrival in the Psychology Department's Laboratory.

PHASE III - Continued System Specification and Initial Implementation

The objectives during this phase were to continue with the writing of the specifications of the Data Entry Subsystem and the initiation of the specifications for the Data Base Subsystem. To support the design of this latter subsystem a survey of existing generalized data base systems was conducted to gain an overview of their capability and design features. This review eventually led to the adoption of the relational data base design for this

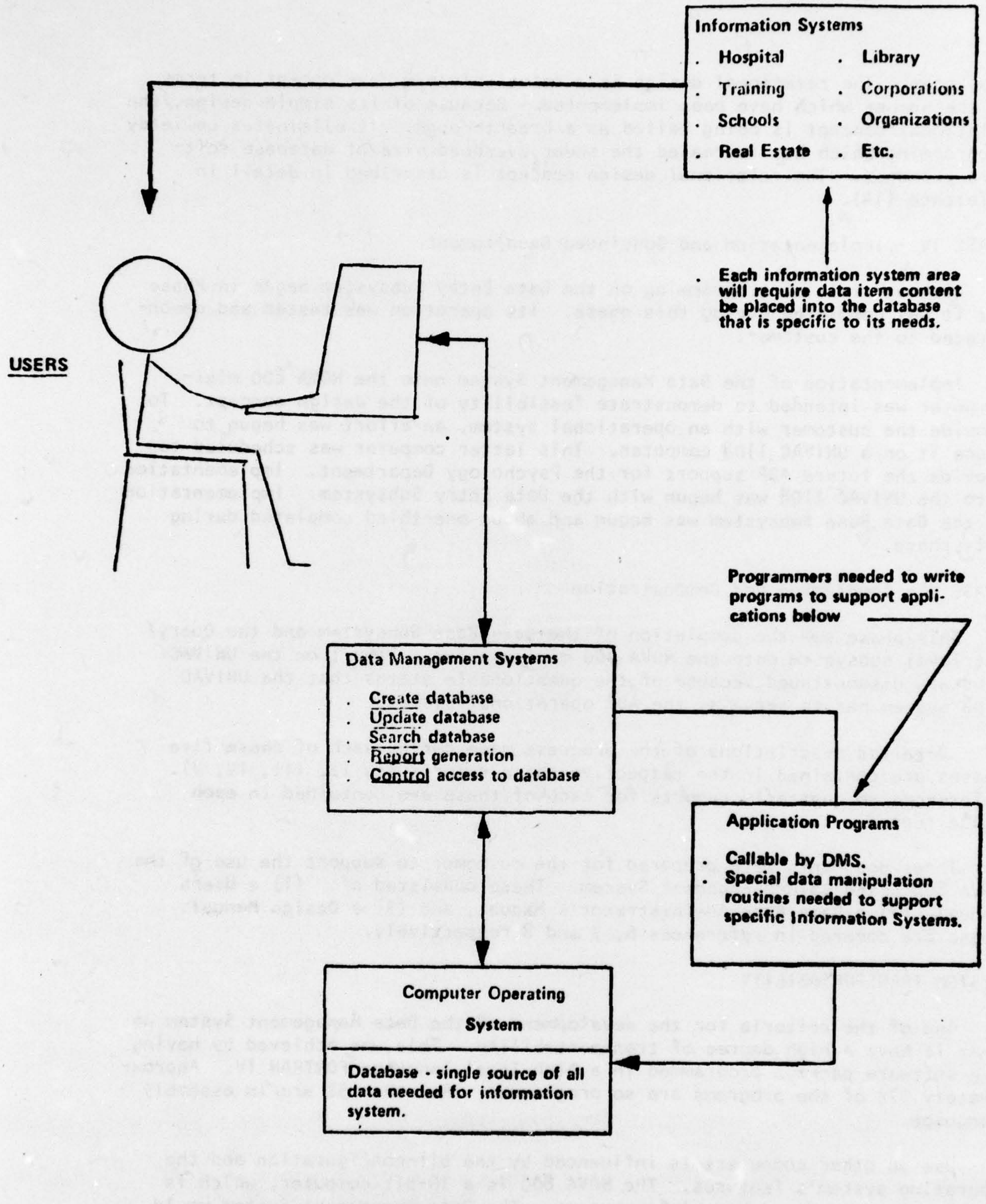

Figure 4.1. Data Management System used to Support Information Systems

subsystem. The relational design is a relatively new development in terms of the number which have been implemented. Because of its simple design, the relational concept is being hailed as a breakthrough. It eliminates unwieldy programming which has increased the sheer overhead size of database software packages. The relational design concept is described in detail in reference (14).

PHASE IV - Implementation and Continued Development

Although initial programming on the Data Entry Subsystem began in Phase III it was completed during this phase. Its operation was tested and demonstrated to the customer.

Implementation of the Data Management System onto the NOVA 800 minicomputer was intended to demonstrate feasibility of the design concept. To provide the customer with an operational system, an effort was begun to place it on a UNIVAC 1108 computer. This latter computer was scheduled to provide the future ADP support for the Psychology Department. Implementation onto the UNIVAC 1108 was begun with the Data Entry Subsystem. Implementation of the Data Base Subsystem was begun and about one-third completed during this phase.

PHASE V - Completion and Demonstration

This phase saw the completion of the Data Base Subsystem and the Query/Retrieval subsystem onto the NOVA 800 minicomputer. Effort on the UNIVAC 1108 was discontinued because of the questionable status that the UNIVAC 1108 system has to serve as the ADP operational system.

Detailed descriptions of the progress made during each of these five phases are contained in the respective phase reports (I, II, III, IV, V). References to quarterly reports for each of these are contained in each phase report.

Three documents were prepared for the customer to support the use of the NOVA 800 based Data Management System. These consisted of: (1) a Users Manual, (2) a Data Base Administrator's Manual, and (3) a Design Manual. These are covered in references 6, 7 and 8 respectively.

SYSTEM TRANSPORTABILITY

One of the criteria for the development of the Data Management System was that it have a high degree of transportability. This was achieved by having the software package programmed in a high-level language FORTRAN IV. Approximately 97% of the programs are so programmed; the other 3% are in assembly language.

Use on other computers is influenced by the bit-configuration and the operating system's features. The NOVA 800 is a 16-bit computer, which is fairly standard for other minicomputers. The Data Management System would operate as is on Data General's line of computers including the ECLIPSE. It would also operate as is on the Digital Control Corporation's D-116 computer.

STEPS TO ACCESS DMS AND TO SIGN-ON

Enter letters DMS via terminal keyboard

DATA MANAGEMENT SYSTEM IS READY FOR SIGN-ON

ENTER YOUR USER NUMBER: (number is placed here)

(all keyboard entries are made at the point designated by the cursor - for this and all other keyboard entries.)

ENTER YOUR PASSWORD: (password is placed here)

(Name of person) SIGNED-ON AT (time and date)

SELECT AND ENTER TRANSACTION FROM THOSE LISTED BELOW:

FILE MAINTENANCE	**WORKFILE REPORT**
CREATE DATABASE	**USER CONTROL**
UPDATE DATABASE	**UTILITIES**
SEARCH DATABASE	**BATCH UPDATE**

ENTER THE TRANSACTION YOU WISH TO PERFORM: (name of transaction is placed here)

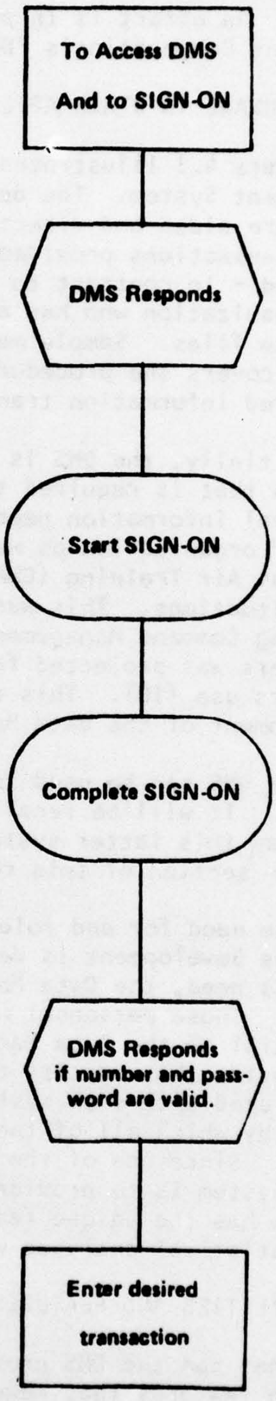

Figure 4.2. Sample Man-Computer Dialog

Conversion to other minicomputers would require about four to six man-months. An effort is in progress to make such a conversion to the Digital Equipment Corporation's PDP 11/70 minicomputer.

SYSTEM USAGE IN OTHER APPLICATIONS

Figure 4.1 illustrates the design and operational concept of the Data Management System. The design incorporates man-computer dialog by which users are aided and directed in their efforts to execute the data manipulation transactions provided. This type of design has been described as user oriented - in contrast to programmer-oriented. A user may be any person in the organization who has a need to access the information stored in the database files. Sample man-computer dialog is shown in Figure 4.2. This dialog covers the procedures and steps by which a user SIGNS-ON and selects a desired information transaction type.

Initially, the DMS is an empty system. The user puts into it the type of data that is required to support the organization's data storage and retrieval information needs. The type of information will vary with the type of organization as well as functions it performs. Within the Chief of Naval Air Training (CNATRA) complex, the DMS has a potential to serve in many situations. This was recognized in the formulation of the Naval Air Training Command Management Information System (NATIS). The use of minicomputers was projected for each Training Squadron as well as for headquarters use (10). This recognition lead CNATRA to endorse the continued development of the Data Management System (9).

The DMS can be used to computerize the files of the Student Management System. It will be recalled that a second major product of this development plan was this latter system. Its features and potential are described in another section of this report.

The need for and role of Management Information System in Instructional Systems Development is described in reference 15. Based on our understanding of this need, the Data Management System would be ideally suited for such a role. Those personnel who are responsible for this area should examine the potential of the Data Management System to fulfill this role. Not only does it provide the capacity to store and organize all of the relevant data types associated with such system development and operation, it also provides the means by which all of these data can be interrelated for their information value. Since one of the prime reasons cited for using an Information Management System is to provide quantitative information, the Data Management System has the unique feature that this quantitative data can be subjected to statistical analyses within the Data Management System proper.

CAPABILITIES AND FEATURES OF THE DMS

What can the DMS provide to an interested user? What are some of its design features that make it of particular use to a wide range of organizations and their personnel? Although it has many features, the most significant of these are:

- It is user-oriented so that the person who needs to use its capabilities can do so directly without the need for either programmer or computer operational personnel.

- Its design includes the use of a database. A database is a collection of data files that are organized so that data items within the collection can serve the information needs of all organization users. The organization of these data files is intended to achieve the highest possible degree of relatability between and among all data items stored in this single source of collected data.

- It provides a large and unique array of man-computer dialogs that are programmed in non-technical english-like language. This dialog guides the user in the proper execution of the selected information tasks. It tells the user what type of an error was made and what his options are when such occur. These latter features promote a high degree of reliable man-computer task completion and information exchange.

- It contains within one integrated package, a total system. Many existing Data Base Management Systems simply provide the database part; to get the other services, you must purchase additional packages from the same vendor, or from some other vendor. The DMS provides the means to enter data for storage into the database, to create the database, to search the database, and to secure reports. You do not need any additional software to implement and to operate a database-oriented information management system.

- The user interacts with the DMS via a display terminal. All of the man-computer dialog appears on the terminal screen. Once the user has informed the DMS of the information task he wishes to execute, the DMS provides the step-by-step instructions.

- The FILE MAINTENANCE transaction makes it possible for any type or number of record/files to be entered, stored, and updated. Limited access to these is provided since this is not considered to be important. The record/files entered are usually those which are currently being maintained manually or on computer files.

- The CREATE transaction provides a capability to organize the contents of files which will better serve the needs of all organization personnel. It is through this create transaction that the database is built.

- The UPDATE transaction provides the means by which the contents of the database can be kept current. This can be done both in an on-line and batch mode.

- The SEARCH transaction provides the means by which the contents of the database can be queried. It provides for single-record searches, multiple-item searches and even a browsing mode where you can literally go from record to record within a file and have any one or all of them printed out. There is the option of what or of how much of the content you want to see on the screen. With the search transaction, you can locate all records that meet a combination of information types. Up to 99 data item combinations can be specified within a search.

- The REPORT and STATISTICS transactions provide the means by which the records located by the SEARCH transaction can be output onto a printer. The STATISTICS transaction permits performance of statistical analysis of the contents of the records located by the SEARCH transaction. The results of the statistical analysis can be viewed on the terminal screen; a hard copy of these results is available via a printer output.

- Through a combination of the CREATE, SEARCH AND REPORT transactions new types of data can be added into the DMS, related to the data currently stored in it, treated with statistics and printed outputs of these statistical manipulations secured.

- Through the USER CONTROL transaction, you can control those personnel who can access the services of the DMS, control the databases and files to which they can have access, and control or limit access to confidential or sensitive information in the database.

SECTION V

STUDENT MANAGEMENT SYSTEM

INTRODUCTION

The Student Management System (SMS) is the second scheduled product of this development program. It is a specific application of the more generalized Data Management System. This SMS product consists of a requirements specification which, when implemented, can (a) provide a set of student handling techniques for achieving greater student individualization of training, and (b) identify the training system data elements and record organization which can support greater individualization and provide other types of management information.

The student handling techniques consist of a set of products and procedures which can be used within a squadron training environment. The products are a family of both individual student and group student performance proficiency profiles. These profiles reveal in detail and in quantitative form the weak, average and strong maneuver skills of the student. With this type of information on the student, both the student's flight instructor and the wing leader are in a more favorable position to plan the student's subsequent hops. Weak areas would be scheduled for greater practice and/or a change in flight instructional techniques. Strong areas would receive less practice time in subsequent hops. Those students who reveal all average and above average manuever skills would be logical candidates for hop duration flight time reduction.

The discussion below will describe the types of student products which can be made available from the existing hop grade data, the squadron personnel who can use the products, and a description of a student-oriented record concept that will support the generation of the products and other types of management information.

FEEDBACK CONCEPTS AND PRODUCTS

To control any complex system, it is necessary that regular information be made available to those personnel who are responsible for its control. The control information must be relevant to the resources and/or activities which need to be controlled in order to meet the system goals and subgoals.

Meeting the subgoal of greater individualization of student training requires that the squadron training personnel take the initiative and execute in a daily manner all of the required procedures. The squadron training personnel involved and the type of products (information) which each could use is illustrated in Figure 5.1.

This illustration embodies the idea of feedback, which emanates from the area of cybernetics, and involves the study of automatic control systems. Automatic control of a process is achieved by the continuous monitoring of the process performance parameters to determine the in-tolerance condition. This monitoring is done by information flow to those who have a concern for the system operation. Based on the 'message' contained in the information

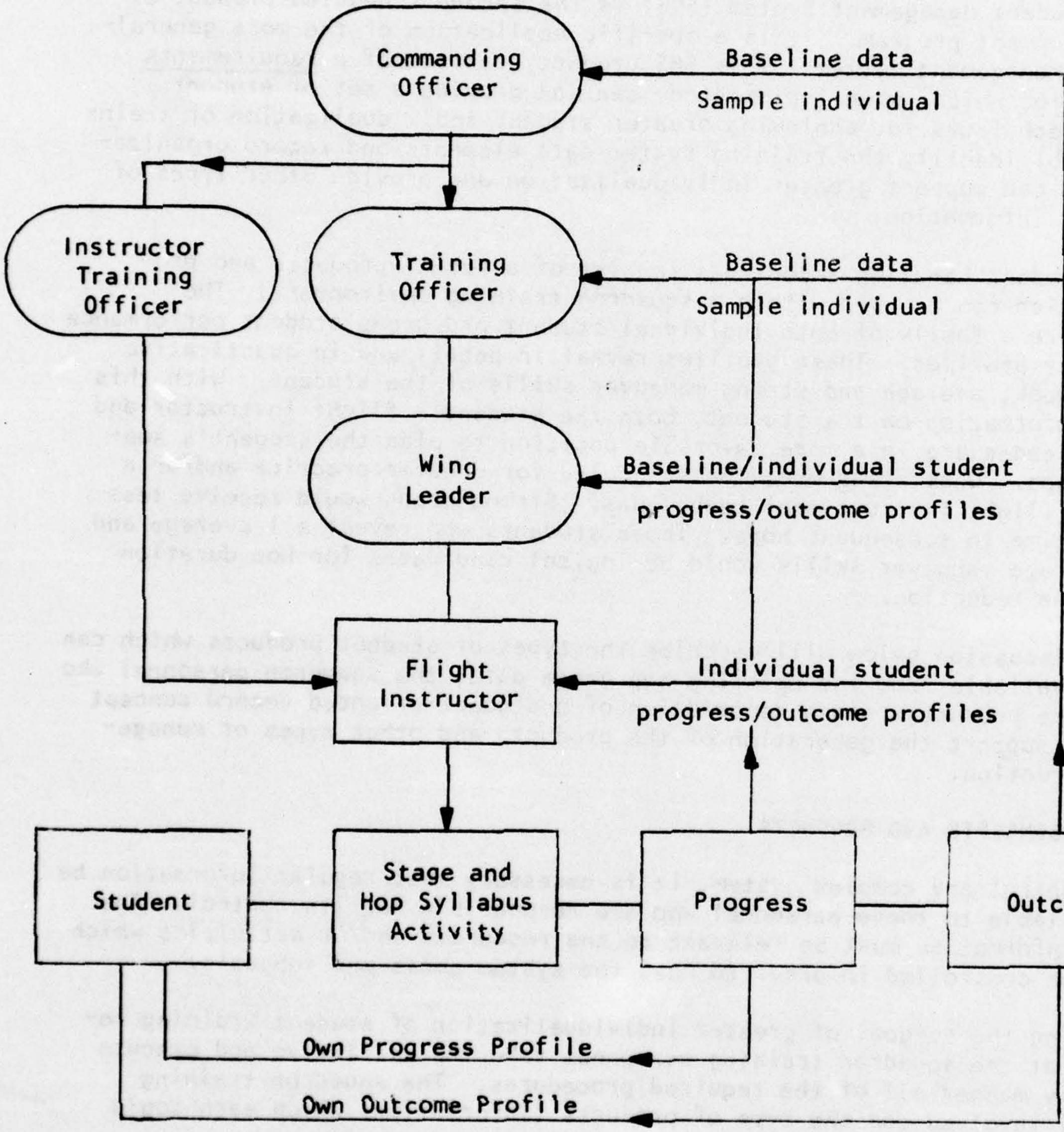

Figure 5.1. Squadron Feedback Model and Product Flows

flow, training personnel take the appropriate action to keep the system moving toward the achievement of increased individualization of student training.

The type of message which each person in the training organization receives is tailored to his duties within the organization. These will be discussed in more detail when the products are described. But at a general level of discussion, the flight instructor would receive the proficiency profiles of those students whom he is currently instructing. Together with the student, the flight instructor would then plan the next hop maneuver content. The student would then be aware of his weaker areas and would have an opoortunity to brush up on the procedures, etc., which are related to the maneuvers. In this manner, a partnership is established to achieve a common goal.

The Wing Leader would receive the profiles of all of the students in his wing. He would review these individually so that he would be aware of the nature and degree of deficiencies revealed by the profiles. Where common deficiencies exist among many students, then this type situation could be discussed among all the wing instructors to explore and to arrive at common types of remedial instructional techniques that may be applied.

The Wing Leader would also receive student profiles at hops 11 and 12 of the presolo stage; such profiles are termed 'outcome profiles.' These profiles would reveal the student's achieved proficiency at the end of his stage training. Where the deficiencies still existed, the Wing Leader would be aware that the remedial instructional techniques were not effective - with no attempt to assign the underlying cause. This situation would be discussed again among all of the wing instructors with the objective of sharing those techniques that did work and those that did not. Through common discussion, and through repeated sessions, the most effective techniques would become evident. When this happens, both the student and the squadron personnel have gained and the subgoals of individualization effectiveness have been promoted.

The squadron training officer's span of responsibility covers several wings and also extends to a total phase of student training. Thus, he needs to be aware of the operation of the student management system and its various products; he should be concerned with the effectiveness of its operation. In Figure 5.1, effectiveness data would be covered by the term baseline data/profiles.

Baseline data would cover statistics on students at the end of the stages and at the end of the phase. These statistics would include (a) trend information on student weak areas at several hop positions in each stage, (b) composite group stage student maneuver proficiency profiles at regular time intervals, (c) accumulative flight-hours statistics of students for each stage and grouped into three student grade categories - lower third, middle third, and upper third, (d) student flight failure statistics which reveal the hop, stage and maneuver(s) failed, and (e) trends in student throughput days by stage and phase. Each of these types of information will not be discussed here since they appear in the yearly program progress reports. However, as can be seen from the types of information, the training officer would be able to detect in quantitative terms the utility and/or effectiveness of the individualization program.

Two other squadron management personnel are shown in the feedback concept illustration. These are the Instructor Training Officer and the Commanding Officer. The instructor training officer should have a concern about the effectiveness of those remedial instruction techniques which are used on the students who have weak maneuver areas. This information can be similar to that which the training officer might receive and include firsthand conversations with the flight instructor and the wing leaders. The idea here is to get the instructor training officer involved in order to obtain the full benefit of his own and his flight instructor experience with varied instructional technique effectiveness. Where the statistics reveal little or no effectiveness then a major goal might be to develop new instructional techniques that would be found more effective.

Since the squadron commanding officer has the final responsibility for the effectiveness of the individualization program, he should be given information about its frequency of application, the percentage of success, and the impact on stage/phase training flight hours, throughput time, attrition, and quality of student graduates.

A summary of the personnel and the products mentioned above is tabulated in Table 5.1.

DESCRIPTION OF FEEDBACK PRODUCTS

A family of feedback products has already been alluded to in the previous material. This section will give a brief description of each product together with an indication of how they can be used to promote the goal of increased individualization of student pilot training.

Individual Student Stage Progress Profile

As the student progresses through a flight syllabus stage, he receives individual grades on each of the scheduled stage maneuvers. After several hops have been completed, it is possible to compute an accumulative grade value for each of the maneuvers. These grade values can then be plotted on a graph to reveal the relative proficiency achieved to date on each of the maneuvers. This graph is termed a profile. A profile has the merit of identifying the student's weak and strong maneuvers as well as the number involved.

Two types of profile have been developed. The first is based on a 4.0 grade system and the second is based on a consistency of performance idea and uses a percentage value computation.

An example of the 4.0 grade system profile is shown in Figure 5.2. This profile happens to be on a student whose cumulative stage grade was 3.046, roughly an average student. When this grade value is taken at face value, it does not reveal any student weak or strong areas. If they do exist, they are obscured by the fact that weak areas can be counterbalanced by strong areas. In the case of the student's profile shown, this is exactly what happens. When the graph is reviewed, it can readily be seen that the student had 4 or 5 very weak areas and a similar number of strong areas. Only about 6 or 7 of the maneuvers fell within the average area.

TABLE 5.1. DATA FEEDBACK TYPES AND POSSIBLE RECIPIENTS

Data Types	Potential Users
A. Progress Data:	
1. Student Maneuver Proficiency Profile	Instructor and Student
2. Student Maneuver Deficiency Profile	Instructor, Student, Wing Leader
3. Student Maneuver Error Profile	Instructor, Student
4. Instructor Grade Trend Profile	Instructor, IUT Officer, Wing Leader
5. Group Maneuver Deficiency Profile	Training Officer, Wing Leader
B. Stage Outcome Data:	
1. Group Maneuver Profile	Training Officer
2. Individual Student Profile	Instructor, Training Officer
3. Group Weak Maneuver Profile	Wing Leader, Training Officer, IUT Officer
4. Group Maneuver Error Profile	Wing Leader, Training Officer, IUT Officer

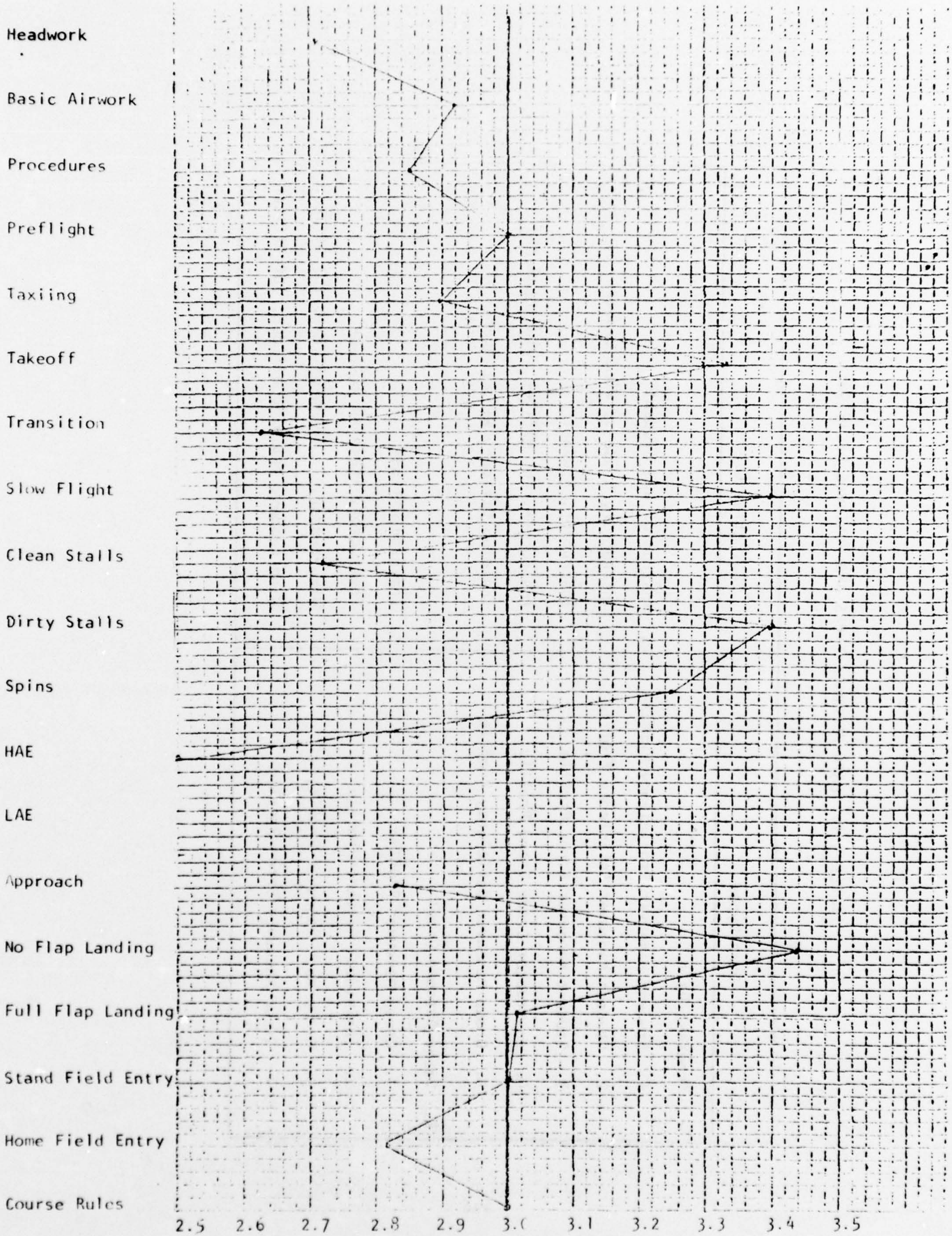

Figure 5.2. Current Grade System Student Profile

Now let us examine a second student. His 4.0 grade profile is shown in Figure 5.3. No weak areas or strong areas are apparent. Yet the student's cumulative flight grade was 3.062 - nearly identical to the previous student. From these two profiles, it can readily be seen that the two students are not equally proficient; also, it is quite evident which one could benefit from some positive individualized training. Thus, the profile technique not only overcomes the limitations of using the cumulative hop grade for progress evaluation but it depicts in quantitative manner the weak and strong areas of the student's syllabus maneuvers.

Student Consistency Performance Profiles

Within a particular stage of flight training, a student is required to practice/demonstrate his degree of proficiency many times. For each hop he is assigned a specific proficiency grade; usually an average, above average, or below average for each of the maneuvers. If we accept the assumption that the student who receives a greater percentage of average and above grades is more qualified than one who receives some below average grades on any one maneuver or on all maneuvers, then it is possible to express these student differences in a quantitative form. This was done for the same students on which 4.0 grade value profiles were made and which were illustrated in the two previous figures. These two consistency profiles are shown in Figures 5.4 and 5.5.

Consistency values are computed by adding the total number of average and above average grades received and then dividing by the total number of grades received. A value of 1.00 indicates that all of the student's grades were average or above. A value less than 1.00 indicates that some below average grades were received. A 0.50 value would indicate that at least one half of the grades received were of the below average category. Thus, faced with a prediction of what the student proficiency level is likely to be on the next hop, this value would be the best estimate.

In the case of the two consistency profiles illustrated, the individual level of maneuver consistency achieved by each student is quite apparent as well as the dramatic differences between these two students. Although the 4.0 grade profile does reveal a student's weak areas, the consistency profile expresses these weak areas in a form which is easily understood and whose consequences can also be readily judged both in terms of current proficiency and next hop estimates. Thus, the consistency profiles reflect a different aspect of student performance proficiency than either a simple hop grade value or the 4.0 grade maneuver profile. For instance, the student who reveals a 0.500 consistency value for HAE/PPEL at hop 11 in the presolo stage might be considered a high risk for soloing! The Wing Leader, the Training Officer and even the Standards Officer would want to be apprised of this student's situation! (Student in Figure 5.4)

Group Student Profiles

These profiles are similar to individual student profiles but their grade values or consistency values are based on the summation of a given number of students' individual grades. These profiles are capable of revealing to the Wing Leader/Training Officer consistent weak, average and strong maneuver areas.

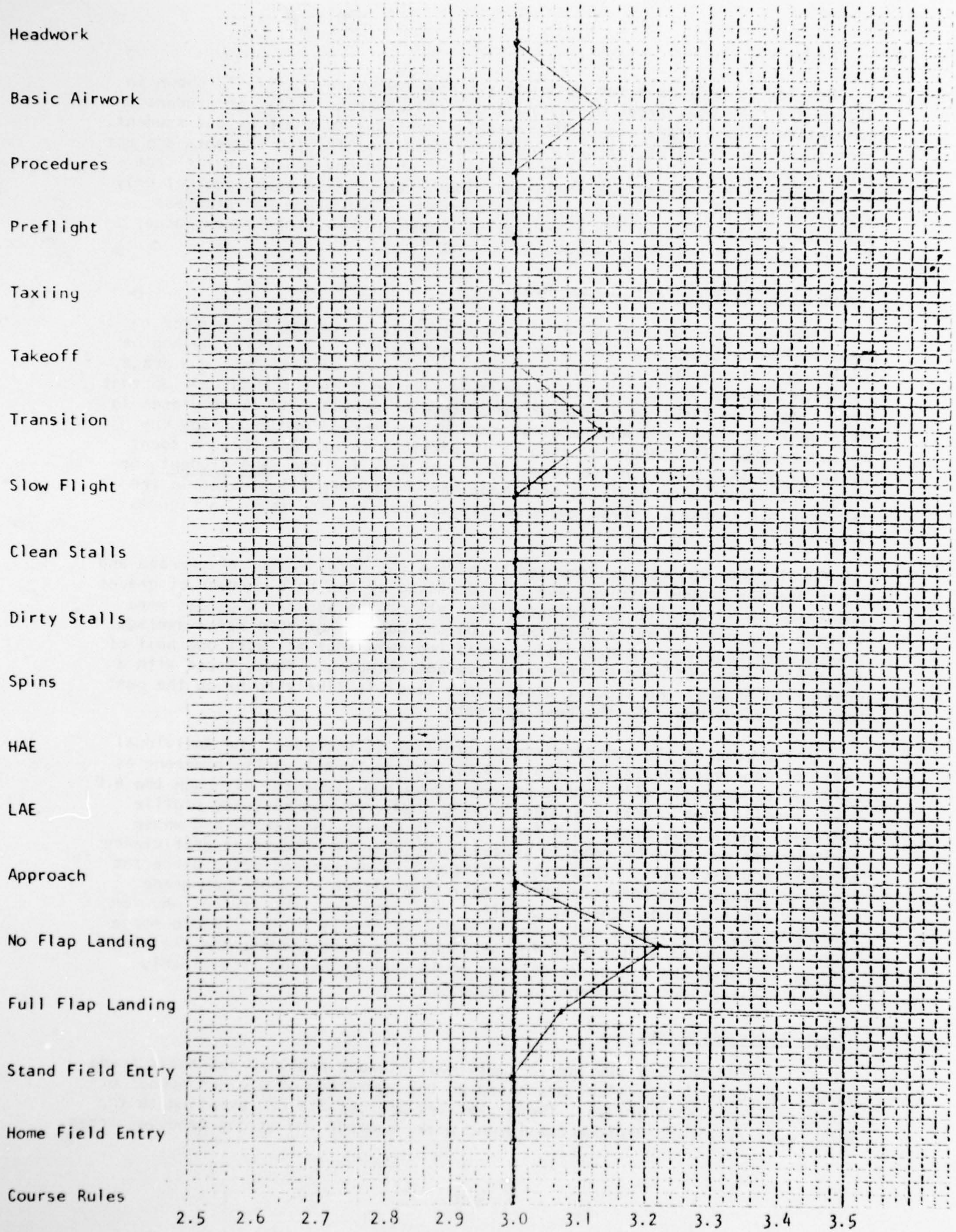

Figure 5.3. Current Grade System Student Profile

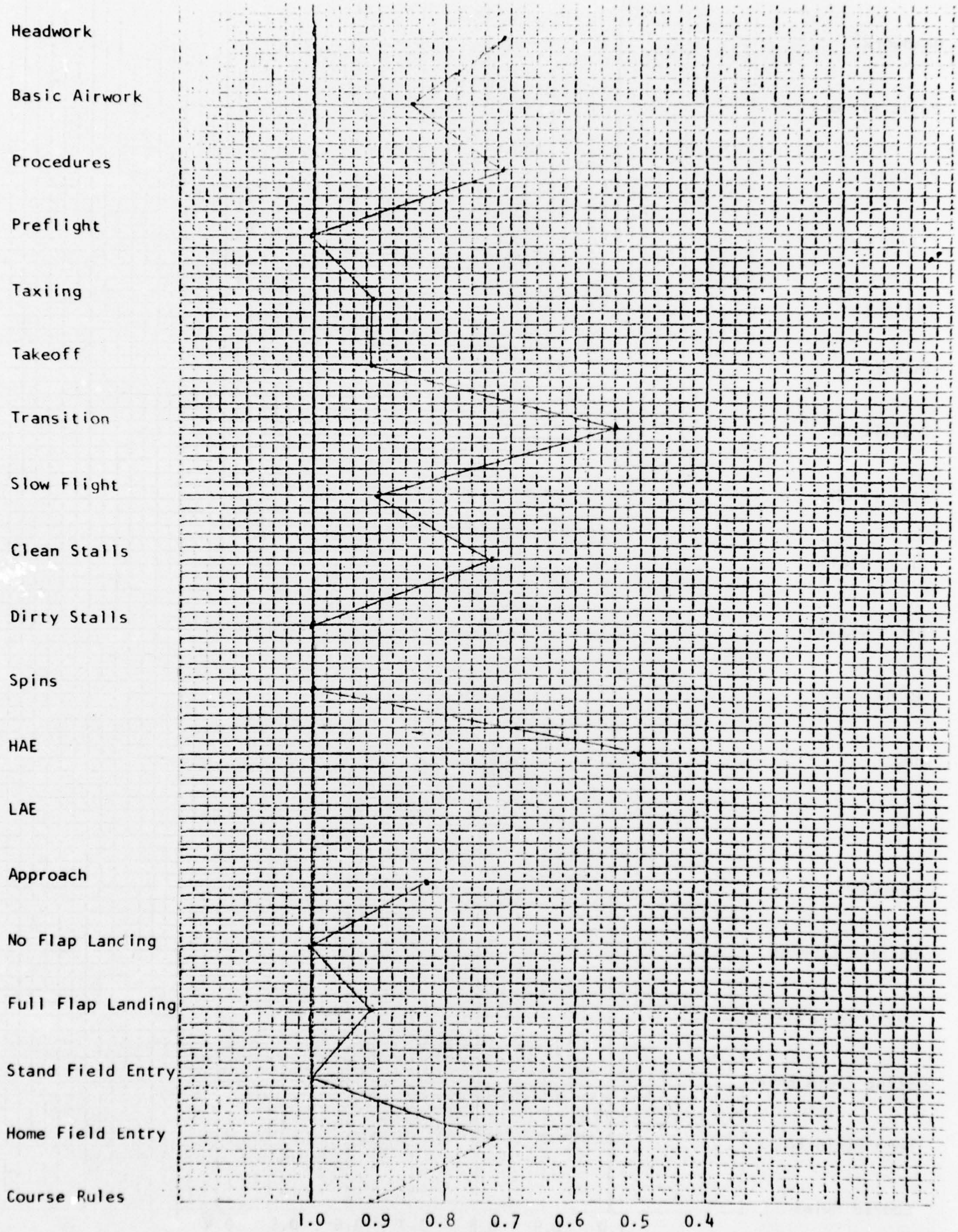

Figure 5.4. Consistency Profile of Student

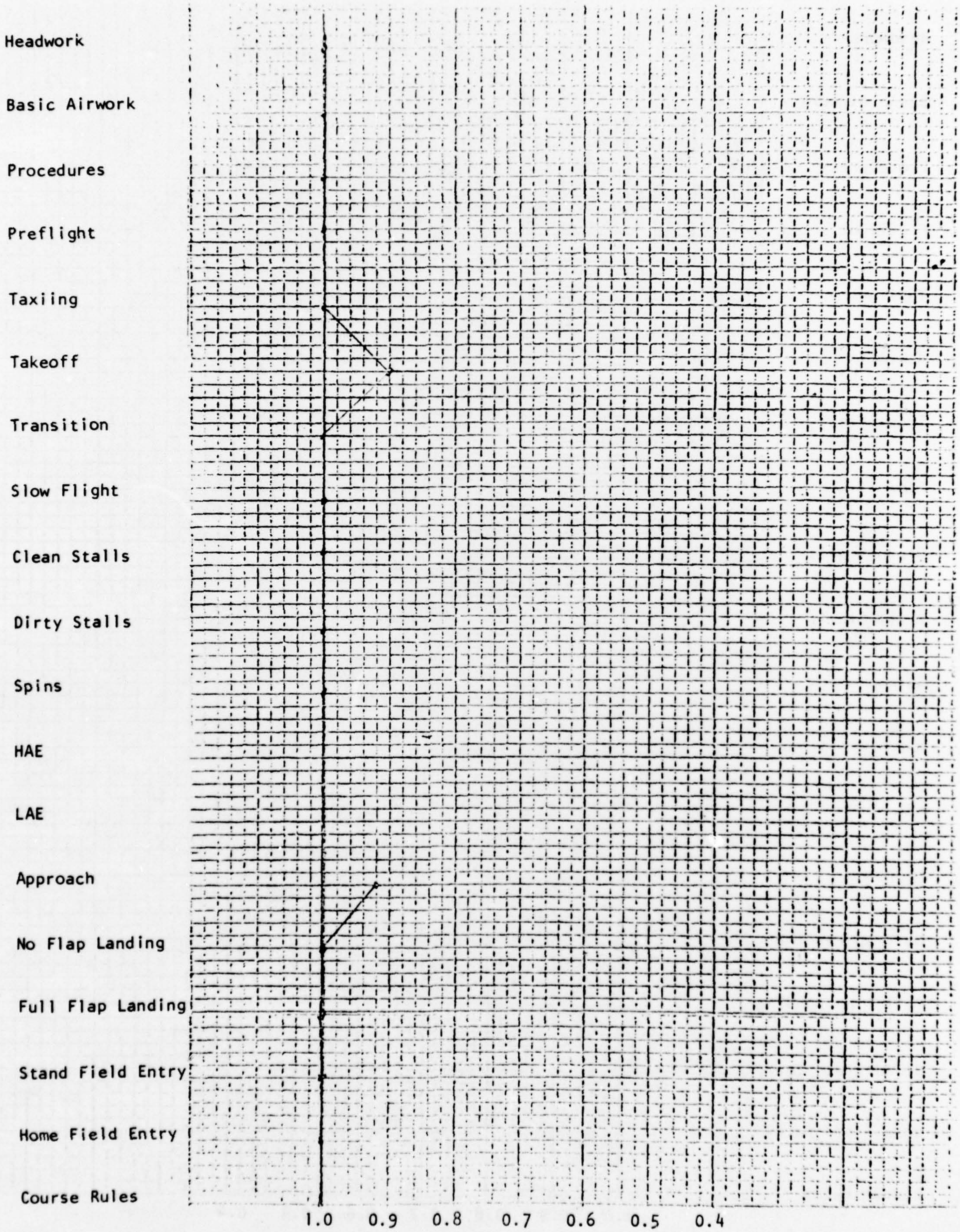

Figure 5.5. Consistency Profile of Student

Where these exist, some type of total squadron effort would be appropriate since they would mean that the existing instructional techniques are not as effective as they could be.

The group profiles at the end of the stage would depict the quality of student graduates. Like the individual student profile, the composite graduate profile would reveal similar information.

To track the benefits that might accrue from the application of an individualized training program, the examination of stage graduate profiles before and after the program had been placed into effect would identify the areas of effectiveness and non-effectiveness.

Baseline Statistics and Impact Trends

The idea of these statistics is to quantify the effects of the individualized training treatments of student. It can be logically expected that if the students and training system are benefiting, some quantitative evidence should be available.

The benefits should reveal themselves in trend type information. The following types of trend information should be made available:

a. Changes in the magnitude of individual and composite student weak maneuver areas.

b. Decreases in the magnitude and number of composite student weak areas at the end of each stage.

c. Decreases in the flight syllabus stage failures where high failure rates were previously in evidence.

d. Where some students are accelerated because they have no weak areas, a reduction in total flight hours per stage should accrue. Again this type of impact will show up only when many students have in fact been accelerated.

e. Student throughput days statistics. At this time, there would be no basis for believing that throughput days of training would be reduced by the above types of student treatments. Flight hours could be expected to be reduced but other factors would more likely determine throughput days. If the profiles were used as a basis for reducing the number of stage hops instead of reducing the duration of flight hops then some impact on throughput days could be expected.

RECORD CONCEPT

Objective

The student naval aviator record concept being proposed herein is intended to fulfill several distinct objectives. The first objective is to build upon the record types now contained in the student aviation training jacket. This

record concept evolved after many years of experience and its current utility is not going to be ignored. The second objective is to build a record concept that will support a continued program of analysis which can help training administrators to detect less effective training operations and to improve upon the training system, thereby achieving greater efficiencies in its operation. The third objective is to provide the means by which greater student individualization of training treatments can be implemented at the squadron level. Individualization of training is used here to denote training treatments to meet each student's needs to a greater degree than current practice permits. A fourth objective is to formulate a record concept that will represent in data form, the physical analog of a student's administrative and training events and which will permit a reconstruction of these events and place them into their proper time position within the total timespan of the student's training period. This objective is considered important because of the fundamental role that the time-domain has in student skill, and knowledge acquisition has in training progress and outcomes.

Record Structure

The record structure which is envisioned at this time and which will fulfill the objective cited above would consist of six separate record types. These records are as follows: (1) administrative, (2) training summary, (3) phase summary, (4) stage, (5) flight hop, and (6) academic. There is a continuous functional relationship between the flight hop record/academic record with the respective stage, phase and training summary records. The functional relationship is depicted in Figure 5.6.

As illustrated, when certain data are input into the ground school and in the hop records, these data are automatically collated and an entry made in the stage record. For instance, when a student completes all of the required hops in a stage, the daily hop grades which appear in the hop record are summated, a 4.0 grade value computed and its outcome is then placed in the stage record. A host of similar functional relationships exist in the proposed structure. These will be discussed in more detail in the material that follows. Similar functional relationships (dependencies) exist between the stage record and the phase record and between the phase record and the training summary record. As the student completes his daily hops, each of the records is automatically updated to reflect his new status. Thus, each record in the structure, when accessed, would reflect his current training syllabus status and his current performance proficiency status. For convenience of reference, the record structure has been designated as being composed of five levels; these are identified in Figure 5.6 as running from 01 to 05. The record will also signify that each level of records and their respective contents is of interest to certain student management personnel in the chain-of-command from flight instructor to CNATRA operations staff personnel.

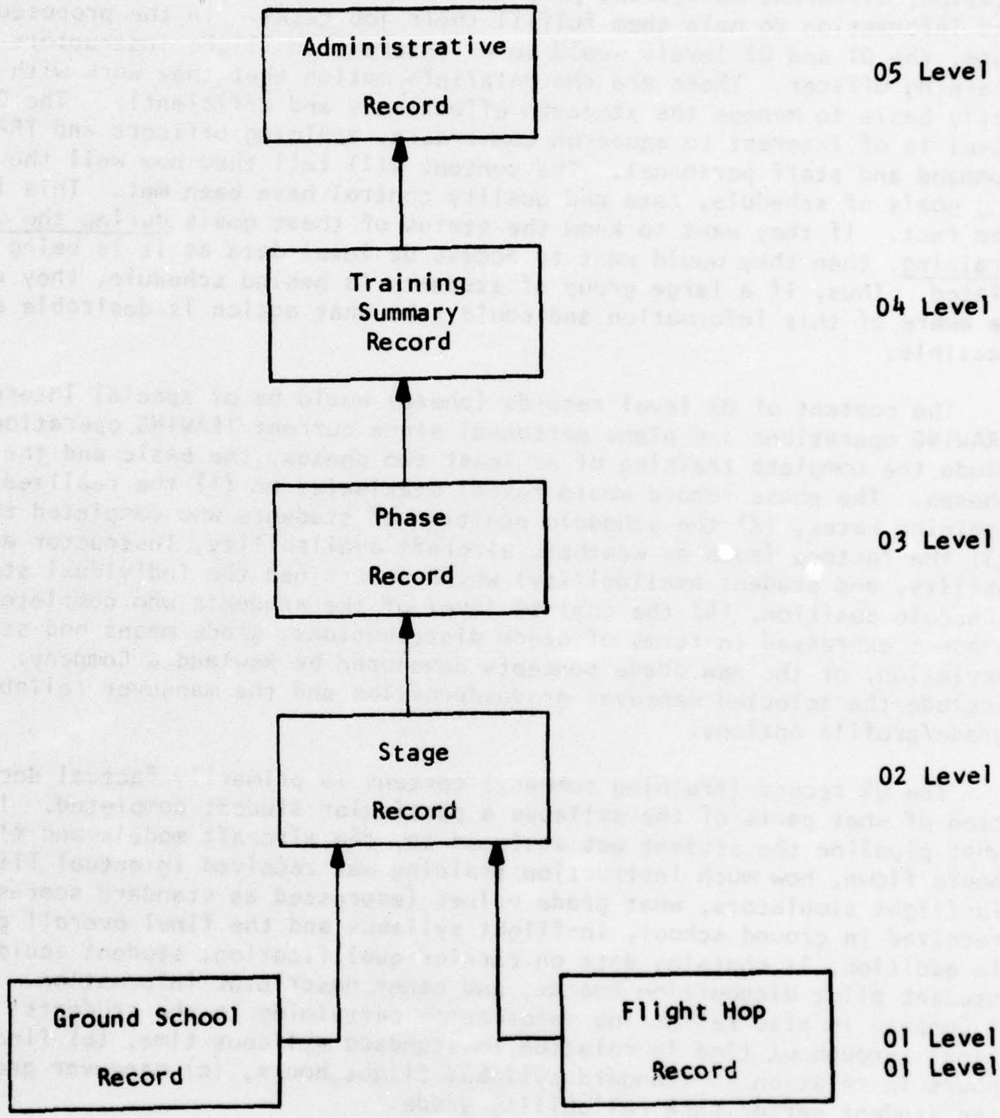

Figure 5.6. Student Management System Student Naval Aviator Record Structure Concept

Record Content and Utility

The content of the records described above was specified so as to support the four objectives cited plus the recognition that, within a training organization, different management personnel have need for different types of data and information to help them fulfill their job tasks. In the proposed structure, the 01 and 02 levels would be of interest to flight instructors and the training officer. These are the data/information that they work with on a daily basis to manage the students effectively and efficiently. The 03 record level is of interest to squadron commanders, training officers and TRAWING command and staff personnel. The content will tell them how well the training goals of schedule, rate and quality control have been met. This is after the fact. If they want to know the status of these goals <u>during the stage training</u>. then they would want to access 02 level data as it is being accumulated. Thus, if a large group of students is behind schedule, they would be aware of this information and could take what action is desirable and feasible.

The content of 03 level records (phase) would be of special interest to TRAWING operations and plans personnel since current TRAWING operations include the complete training of at least two phases, the basic and the advanced phases. The phase record would reveal statistics on (1) the realized Pilot Training Rates, (2) the schedule position of students who completed the phase, (3) the factors (such as weather, aircraft availability, instructor availability, and student availability) which determined the individual student's schedule position, (4) the quality level of the students who completed the phase - expressed in terms of grade distributions, grade means and standard deviation, or the new grade concepts developed by Rowland & Company. These include the selected maneuver grades/profiles and the maneuver reliability grade/profile options.

The 04 record (training summary) content is primarily factual documentation of what parts of the syllabus a particular student completed. It tells what pipeline the student was assigned to, the aircraft models and flight hours flown, how much instruction training was received in actual flight and in-flight simulators, what grade values (expressed as standard scores) were received in ground school, in-flight syllabus and the final overall grade. In addition, it contains data on carrier qualification, student accidents, student pilot disposition boards, and other descriptor information. Rowland & Company is also reflecting information pertaining to the students' (a) final throughput time in relation to standard syllabus time, (b) final flight hours in relation to standard syllabus flight hours, (c) maneuver grade and the student performance reliability grade.

The 05 record (administrative) content is primarily for unique identifying data about the individual student. This consists of traditional items such as name, social security number, branch of service, rank, date of rank, etc. The content of this record may well follow that being developed for the Personnel Record of the planned NATIS. Rowland & Company does not have any special content recommendations for this record. Its primary use is to keep Navy administrative information separate from the CNATRA training function records.

RECORD DESCRIPTIONS

This section will describe each of the six record types already introduced. The specific content data element type and the quantitative value of each will be indicated where possible. The source of the data which goes into each record will be identified; this will be done especially for those data types which tie one record into another in terms of dependency. Since a cumulative dependency exists from the top record downward, it is planned to discuss the records at the lowest level first so that the proper data elements will have been introduced in a record which feeds upward into the higher level records.

Hop Record

The hop record would contain all of the information now contained on ATF type forms. For discussion purposes, it has been separated into (a) administrative, (b) training syllabus, (c) hop description, and (d) maneuver/grades of that hop.

The administrative data would consist of identifying data such as student SSN#, and NAME.

The training hop identification would consist of such data as (a) syllabus hop number designation, (b) date of hop, (c) instructor identification number, (d) hop duration, (e) type of hop - solo or dual, (f) hop type in terms of regular, extra time, special check; and (g) hop outcome in terms of up or down.

The maneuver/grade data would consist of an itemization of each hop maneuver type demonstrated, practiced and/or graded - together with the grade assigned to each. In addition, the grade for that hop would be shown.

The cumulative maneuver grade data would consist of a running total of (a) the number of unsat grades, (b) the number of BA grades, (c) the number of A grades, and (d) the number of AA grades.

A hop record would exist for each hop flown. Access to a particular hop record would be via the student's SSN and syllabus hop designation number. The format for the display of the hop record data on the terminal screen is not a topic of this working paper. The format would have to be coordinated with user type squadron personnel.

A listing of the above data elements is shown in Figure 5.7.

Stage Record

The stage record would be a running and final summary of all training events in each stage of training. Depending upon pipeline, there are approximately 20-25 stages. Thus, each stage record would have a unique identifier. These identifiers would correspond to those already being used in the syllabus file.

HOP RECORD

Identification
- Name of Student
- APL Number
- Training Stage
- Stage Hop Number

Administrative
- Hop Date - M/Y
- Hop Duration - hrs/tenths
- Hop Type - regular, special, etc.
- Hop Up or Down
- Solo or Copilot
- Aircraft Type

Instructor Number

Hop Grade Data
- Number of unsatisfactory grades
- Number of below average grades
- Number of average grades
- Number of above average grades

Cumulative Hop Grade
- Cumulative unsat grades
- Cumulative below average grades
- Cumulative average grades
- Cumulative above average grades

Maneuver Grade Data
- Maneuver identification
- Maneuver grade
- Maneuver identification
- Maneuver grade
- etc.

Figure 5.7. Hop Record

STAGE RECORD

Identification
- Name of Student
- APL or SSN of Student
- Syllabus Stage

Administrative
- Squadron ID
- Date Started
- Date Completed
- Aircraft Model

Schedule Position Data
- Projected completion date
- Actual completion date
- Hop-days lost:
  - Weather
  - Aircraft availability
  - Instructor availability
  - Student availability
  - Other

Cumulative Stage Grade Data
- Number of unsat
- Number of below averages
- Number of averages
- Number of above averages

Maneuver Profile Data
- Reliability value for each stage maneuver
- Cumulative grade for each stage maneuver

Flight Hours
- First Pilot - standard
- First Pilot - actual
- Copilot - standard
- Copilot - actual

Figure 5.8. Stage Record

The stage record would contain (1) administrative data, (2) training squadron data, (3) schedule position data, (4) stage maneuver profile data, (5) cumulative flight time, and (6) cumulative raw grade data.

The administrative data would consist of the student's name, social security number, pipeline assignment and stage identification.

The training squadron data would consist of squadron identification, date student reported in, date student reported out and aircraft model being used in this stage.

The syllabus schedule position data would be a running summary of the current student's schedule position. The position would be expressed in terms of the number of hops - behind, ahead or 0 for on-schedule. When a hop is lost, the reason for the loss would be recorded as (a) weather, (b) aircraft availability, (c) instructor availability, or (d) student availability. The information from this record would serve as inputs into the scheduling officer's data needs.

The cumulative stage profile data would consist of computed data expressed either as 4.0 grade value or in reliability terms and would reveal the student's current proficiency on each of the stage maneuvers. Being a cumulative profile, the grade data from each stage hop would be used to compute the data values for the profiles. The profiles would be available to the flight instructor or training office either as displayed on the terminal or as a printed output.

The cumulative stage grade data would still be available to flight instructors, training officers and student disposition boards. These data would consist of the cumulative number of (1) unsat grades, (2) below average grades, (3) average grades, and (4) above-average grades. In addition to these, a cumulative stage grade value would be automatically computed from the above and the value stored in the record. This value would be updated after each hop. This same value would then be used as the stage grade when the stage hops had been completed.

The cumulative flight time hours data would consist of (1) first pilot hours, (2) co-pilot hours, and (3) number of hops flown. These data would serve as inputs into the phase record where similar type data are being accumulated.

A listing of the above data elements within a record layout is shown in Figure 5-8.

How can training administrators use the data placed into the stage record to achieve training system goals and achieve individualized student training treatment goals?

Training system goals are the achievement of a training schedule for each student so that a projected training rate can be met and a quality student product achieved that has a low risk of future failure. As the student progresses from one stage to another the information about the student's schedule position is available. If a group of students are behind schedule at the end of the 2nd stage of training, then this information can be used to give priority to their scheduling in the next stage or stages in order to overcome their behind-schedule position. In this way, the projected training rate is more likely to be met.

Each stage record contains data which can be used to secure a set of syllabus maneuver profiles for each of the stages completed in the phase. The profiles reveal the relative strength and/or weakness of the student on all maneuver types and may be used to detect the presence of consistent weak areas across all stages. For instance, a student who blew emergency procedures at all stages of his training would be a higher risk student than one who had consistently average or above average grades. Such a student could be given extra-hops to help him overcome this area rather than send him on to the next stage/phase with known weaknesses. The reliability value for each stage maneuver is useful for the detection of these weak areas.

Phase Record

The function of the phase record is to provide TRAWING and CNATRA command personnel with information about the student's training progress, his training outcomes, and to document syllabus status achieved. As is true of other records, the data content will appear under several descriptive headings. These are described below.

Administrative. This type of information will consist of specific student identification descriptors. The content would be identical to that used in the hop, stage and administrative records. As a minimum, these would include (a) the student's proper name, (b) his social security number, (c) his branch of service, (d) his current rank. These latter two data elements are not essential since they will appear in the Administrative Record which will be discussed later in this report.

Phase. This type of information will consist of descriptors that document on which pipeline syllabus the student received his training, the D/M/Y of the beginning of training and the D/M/Y of completion of phase training. Where pipeline cross-overs occur, this fact should be reflected under this section of the record.

PHASE RECORD

Identification
- Name of Student
- APL/SSN of Student

Phase Data
- Phase Name
- D/M/Y Started
- D/M/Y Completed

Schedule Position Data
- Projected Completion Date
- Actual Completion Date
- Cumulative Hop Days lost:
  - Aircraft Availability
  - Instructor Availability
  - Student Availability
  - Other

Cumulative Grade Data
- Flight Grade
- Ground School Grade
- Phase Grade

Flight Hours Data - Cumulative
- First Pilot - standard
- First Pilot - actual
- Copilot - standard
- Copilot - actual

Figure 5.9. Phase Record

Training Status. This type of information documents what actually happened in each stage but does it in a summary form. The summary data will determine, among other things: (1) the syllabus schedule actually achieved by the student; (2) the factors which influenced the schedule position made good; (3) the quality level of the student's performance in the ground school and flight portions of the syllabus; and (4) the total flight hours required versus the standard flight hours of the syllabus. The specific data elements which this section should contain are as follows: (1) date started first stage (D/M/Y): (2) date completed last phase stage (D/M/Y); (3) elapsed days; (4) syllabus phase schedule position expressed in relation to the published 'standard' schedule duration; (5) a tabulation of the factors which contributed to the deviation (if any) from the standard schedule (consider expressing these as both absolute numbers and in terms of percentage, i.e., what percentage was due to weather, what percentage due to lack of aircraft availability, etc.); and (6) the number of solo and dual flight hours flown expressed in hours and an entry which compares these hours to the number in the syllabus. This latter number would have to be computed and at this time it is suggested that a percentage of hours flown over the standard or below the standard be computed.

Phase Outcome Data. In the above section, mention was made of two computed values, the phase schedule position and the flight hours position in relation to the published standard. The raw data on which these two computed values would depend would appear in the above record section but the actual computed values would appear under the Phase Outcome Data. Thus, two percentage values would appear, a percentage above or behind phase schedule and a percentage less than or greater than the standard flight hours.

One other type of Phase Outcome data suggested to provide a complete documentation is the cumulative grade value achieved for the ground school syllabus and the cumulative grade value for the flight syllabus. Consideration should be given to combining these two values to secure a 'final phase grade'. Any one of the previously described metrics can be used but the one that provides the greatest student performance discrimination is favored. The administrative utility of the phase grade is to provide some quantitative expression of the 'quality of student performance' achieved by the TRAWING and its supporting squadrons.

When the above types of data are collected and computed for each phase and are made available to TRAWING command personnel, they would be in a position to examine their own operations for out-of-tolerance conditions and, where any exist, review the options available to them and execute those that seem to have the best promise. For instance, Pilot Training Rate and Schedule are the two goals which each TRAWING is trying to meet. The phase record data will permit them to identify the factors which influence the pilot training rate and schedule positions and also to relate these to resources used (number of aircraft hours flown, number of flight instructor hours used, number behind due to large proportion of marginal students, etc.).

The above types of relationships can be made available to command personnel with the data base type of file organization. However, before this can be done, the command personnel must indicate that they wish to have such

information made available via online query or via weekly or daily reports, etc. Weekly summaries can be fulfilled by batch processing whereas daily reports or summaries can easily be provided via online mode of operation.

The content and layout of the phase record appears in Figure 5.9.

Individualization Information. The phase record as described so far simply tends to 'document' what happened during a particular phase of training. But how can this record contribute to greater individualization of training?

The phase record, together with the individual stage records, can be used to secure comprehensive profile information on each student.

As the student nears completion of the last stage of the phase, administrative personnel must decide whether the student has, in fact, met all of the syllabus requirements and whether the standard of performance achieved is sufficient to pass the phase and to prepare the student for the next phase of training. A basic thesis of the SMS development effort is that most of the traditional grade data do not provide a complete enough basis for the identification of student weak areas, strong areas and intermediate performance areas of the flight training syllabus. Therefore, if the phase summary record is to play a significant role in decision-making about the student, then this record, together with the information contained in the individual stage records, can be used to help decide on the proper treatment for the student. If the stage records were used to detect student weak areas systematically, then, by the time the student completed the phase his known deficiencies would have been given attention. The decision to be made at the end of the phase is whether the weak areas were, in fact, detected, what remediation was attempted and with what outcome. With this information, the TRAWING commander has information about the effectiveness of the detection system, the effectiveness of remediation efforts, and the effectiveness of efforts to achieve and maintain the projected training rate.

Training Summary Record

This record is intended to document major factors about the student's training in the training command. The major factors include: (1) those background characteristics of the student that have shaped his entrance skills and knowledges; (2) the specific training syllabus under which the student was, in fact, trained; (3) the outcome of the training either in terms of attrition or completion with detailed grade and qualifications achieved; and (4) administrative events such as student disposition board occurrences, accident data and other administrative decisions that impacted on the student's career. After a tabulation of the respective record sections and their specific data elements is made, the utility of the sections/data elements will be discussed.

Student Identification Section. This section would contain that data which CNATRA has established as a minimum for personnel identification. Shown in this section are the student's full name, social security number and/or service number, the branch of service and rank. These data should serve to uniquely identify one student from every other student.

TRAINING SUMMARY RECORD

Identification
- Name of Student
- APL/SSN Number
- Service Branch
- Rank

Background
- Procurement Source
- FAR Score
- AQT Score
- Prior Flight Experience

Training Syllabus
- Pipeline
- Syllabus Designations
- Phases or Stages

Training Outcome
- Completion Date
- Attrition Date
- Attrition Stage
- Attrition Hop/Maneuvers
- Attrition Reason(s)

Proficiency Achieved
- · Cumulative flight grade
- · Ground School grade
- · Final Overall grade

Resources Used
- · Throughput days
- · Solo Flight hours - aircraft
- · Dual Flight hours - aircraft

Schedule Position Summary
- · Projected completion date
- · Actual completion date
- · Hop-days lost:
  - · Weather
  - · Aircraft
  - · Instructor
  - · Student
  - · Other

Figure 5.10. Training Summary Record

Background Factors Section. Two factors of the student's background which shape his entrance level knowledges, skills and attitudes are educational experience and prior flight experience. To qualify as a candidate for aviation training the potential candidate must take several tests. The results of the tests are recorded as scores on the Flight Aptitude Record (FAR) and the Aviation Qualification Test (AQT). A minimum score of stanine 3 and 5 on these respective tests has generally been in effect. However, the minimum score for AQT for certain branches of service has been set at 3. This type of information exists in some administrative documents but does not get recorded on the student's record. This section would be a logical place for its recording. Whether a student naval aviator candidate enters from civilian life or from the service has been shown to influence his probability of dropping from the flight program voluntarily. The data element which has made such determination possible is the identification of the procurement source of the student. In the past, a procurement source of AOCS has been used to designate a candidate from civilian life. NROTC has been used to designate a candidate who was enrolled in the Navy Reserve Officers Training Course.

Prior flight experience of a candidate could have been via the Flight Indoctrination Program (FIP) in the NROTC program or through a civilian flight school. Some students, who were released for the convenience of the government because of a surplus of students, have been designated as COGS. Certainly, this previous experience will impact on the student's rate and level of progress. When making analyses of groups of students, it is essential that all of the students are grouped together since it could be analagous to comparing apples and oranges. This error can only be avoided if the student's record contains data elements that make these important identifications.

Training Syllabus Section. This section of the record would document in which of the pipeline syllabuses the student received his training and the specific syllabus codes which would identify the specific version which was in effect during his training.

Syllabus Change Documentation. At this point it is desirable to amplify on the necessity that the particular syllabus under which the student received his training be documented. For instance, in the period prior to March 1970, student naval aviators received their primary flight training prior to their training in officer candidate school. After March of 1970, the syllabus was changed to flow to Aviation Officer Candidate School and then to Primary Flight Training. Currently under consideration and about to be implemented in the Basic Phase is the parallel training of a student in Instrument Flight and Aerobatics and possibly some other type stage training.

Most of the above types of changes are made and recorded at an administrative level but no data items appear in the student's record to document this type of syllabus training. Thus, when any attempt is made to follow-up on the consequence of the changes the data elements are lacking to reveal which students were trained under which syllabus. Therefore, follow-up analyses of the consequences of changes in syllabus cannot be made except by combining data from CNATRA administrative records which document when these changes took place, what the nature of the changes was, and then trying to identify those students who were, in fact, trained accordingly. Therefore, it is highly recommended that CNATRA establish and maintain a master syllabus

record in which major syllabus changes are documented, the date of their implementation and the syllabus stages which are effected. Furthermore, whenever such a change occurs, the appropriate syllabus code or change must be recorded on the student's Training Summary Record. To accommodate this type of data, the training summary record concept being proposed herein contains a subtitle under which changes can be accommodated. The exact data elements that would go into this section depend upon the system CNATRA establishes for the identification of syllabus changes, etc.

Training Status Section. An examination of this section by training personnel would reveal the current training status of the student. The data would be automatically updated from data which becomes available to the Phase Record.

The current training status of the student would include the following types of information:

a. current stage of training
b. current syllabus hop
c. current total syllabus schedule position
d. factors which determined student's schedule position
e. current proficiency status - expressed as overall grade in standard grade - using all available grades assigned. For deficiency profile data, would have to go into Phase and Stage records.
f. number of instructors student flew with
g. total number of solo and dual hours flown
h. probable completion date based on current squadrons and student's characteristics.

Training Outcome Section. This section would contain data only when the student has completed the prescribed syllabus or has attrited. For those who attrited the training status section would reveal how far the student progressed; data elements would reveal the stage, hop, maneuver(s) failed and the voting outcome of the board and admiral.

For those students who completed several subsections would be included. These subsections include (a) Proficiency Achieved, (b) Schedule Achieved, (c) Flight Hours Required, (d) Flight Instructors Used, (e) special qualifications achieved such as CQ, gunnery, etc., (f) accident data, if any, and (g) board data which did not result in an attrition.

1. Proficiency Data: All students achieve a Final Overall Grade. This final overall grade is currently made up of ground school grades and flight syllabus grades. When these two are combined in accordance with a formula a single grade expressed in standard score form is secured. The actual value of this score will permit any student to be compared with any other student and a ranking of students can be made where administrative decisions need such information.

Although the single grade value permits a comparison of students with each other, it does not reveal the existence of any strong or weak flight maneuver skills. To secure these types of data, it would be necessary to access the

stage records of the student. Strong and weak skill areas tend to be specific to the aircraft and stage syllabus maneuvers. The areas of strengths and weaknesses can be readily identified by the performance reliability metric and/or profile. This topic was discussed under the Stage Record description.

2. Schedule Achieved: This section would contain information and data elements which revealed the actual syllabus schedule achieved. The information would appear as (a) standard syllabus days/weeks, (b) achieved syllabus days/weeks, (c) percentage of days/weeks ahead or behind syllabus standard, (d) tabulation of actual number of days lost due to weather, aircraft availability, instructor availability and student availability. These data could be supplemented by computational data which tabulate the percentage of time lost to each of these factors; or this type of computation may be included in an application program that retrieves the raw schedule data and then makes the percentage computation, especially for a large group of students. For instance, weather factors could conceivably have a different effect on schedule based on the season of the year. To perform a relevant analysis on this differential effect it would be necessary to look at how weather influenced each stage type, but with the precaution that the same time periods would be examined. How would those stages be identified, say, that received their training in the spring of the year? This would have to be done by looking at those students who began their stages in the month of March and completed by May. As described in the proposed Stage Record the data elements would be there and such an analysis would be facilitated.

3. Flight Hours Required: Each student flies a certain number of hops and when the durations are summated a total flight hours value is available. Each squadron currently records the total hours of solo and dual for each stage. The phase record would summarize the stage record data. When the student has completed his training the total that appears on the phase record would automatically be transferred to the summary record and be placed in this section.

In addition to containing the total required hours the standard number of hours required for the particular syllabus would appear. Thus, the number of hours above or below the standard could readily be seen when the record was examined. An optional data element would be to compute a percent hours above or below the standard and the placement of this value in this section.

The utility of these types of data would support the examination of any student's progress in terms of the number of hours needed to qualify as a naval aviator. An operational definition of a good student pilot could well include the number of flight hours needed to qualify. There is already preliminary evidence that higher graded students are given less hours by their flight instructors than lower graded students. Thus, flight hour ranking among students may well be a useful metric that can be used to differentiate between students who have the same overall cumulative training grade. The analysis of flight hour distributions of students at the end of individual stages and phases reveals more diversity than grade data distribution. Admittedly, this is a secondary type of evaluation criterion in comparison to the grade value per se.

The content and layout of the summary record is shown in Figure 5.10.

Administrative Record

This record would contain data pertaining to the student's Navy career per se rather than any data about his training. No attempt will be made to itemize these data since they are dictated by established policy and procedures. All of the records already described would remain within the training command and would not be forwarded when the student left for operational training. However, some liaison with the operational training command should be retained to determine the utility of forwarding some types of student data which would reflect the student's various proficiency levels achieved. If the operational training command decides to maximize individualized training treatments then some data about the student may be required.

SECTION VI

SUPPORT TASKS

INTRODUCTION

The development plan and structure contained a third major task. This third task is entitled "Support Tasks." The idea behind this was to assemble data and information that could impact on the design of the Data Management System and on the Student Management System. Four such support tasks are shown in Figure 3.3, the task and phase summary. The scope of effort and the results of each of these areas are reviewed below.

EXPERIMENTAL DATA BANK

The Experimental Data Bank is a computerized file that contains selected records of student naval aviators. These records cover students who received and completed their training during the 1970/71 calendar years. The records were placed on magnetic tape files and used the UNIVAC 418 computer for their preparation and analysis.

The primary reason for the creation of the Experimental Data Bank was to provide the means by which objective, empirical, quantitative information could be generated about a wide range of topics. It supports all of the quantitative data developed for the Student Management System. It also provides all of the quantitative data which supports the contributions made to the Student Success Prediction System and to the Training Systems Analysis task areas described below. Thus, the creation and operation of the Experimental Data Bank formed a cornerstone upon which the development program was built.

The broad types of data contained in this bank are described in the following paragraphs.

1. Flight Maneuver Error Data

For each hop flown with a flight instructor the errors made by the student are recorded on a standard form. This form contains the list of all maneuvers flown, the grade made on each maneuver, and some written comments about the nature of the errors the student made on those maneuvers which were graded below average and average. For a group of 25 students who had completed their training of the presolo stage of training, the hop record forms were secured. To enter the error data into the computer a coding system was devised to identify the specific maneuver and maneuver sub-task to which the errors belonged.

Within a training system that uses subjective grade assignments such as average, below average, etc., the error-data may be viewed as being less influenced by instructor biases. A grade is a subjective expression of the errors made by the student. The value of the error-data is that it is these errors, whether they be constant or random, that must form the basis of any meaningful student remediation effort or of a program to implement greater student individualization. It is the errors that must be remediated and not

the grade which is but a symptom of the errors. A student maneuver error profile was developed to help give quantitative tabulations of these errors. A sample profile is shown as Figure 3.7 in reference 1. The relation of error-data to grade data is discussed in detail on page 3-5 of reference 2. A complete discussion of these data appears on pages 4-2 through 4-10 of reference 2.

2. <u>Flight Maneuver Grade Data</u>

For a selected group of students, the grades made on each maneuver of each hop of the three phases of training were placed into the data bank. This amounted to approximately 3,000 maneuver grades per student, plus a separate hop grade for each of approximately 250 hops.

The data were analyzed systematically to develop student stage grade profiles for each stage in the basic phase and each stage in the advanced phase of training. These profiles are contained in references 3 and 4 respectively. The data were also used to secure statistics on student throughput time and flight-hours required for students in each of the stages as well as for each of the two phases of flight training. These data are discussed for the basic phase in reference 3 and for the advanced phase in reference 4.

3. <u>Student Evaluation Board Data</u>

When a student is having difficulty with the training syllabus, a board of officers convenes. This board reviews the student's total situation; his previous performance, his current performance and any personal problems that he may be experiencing. Based on their evaluation, the board recommends either that the student be dropped from further training or retained with a recommendation of the type of remedial training he should be assigned. Under this system, some students may accumulate up to three or four board hearings while they complete the total training program.

Previous research conducted by the Aerospace Medical Research Laboratory has revealed that the use of a board event on students contributed to an improved prediction of their future risk of pass or fail. Thus, there was interest in placing as much of these types of data into the data bank as possible to help exploit the data on a large group of students.

When the above types of data are combined with the selection and training data which reside on the NAMRL's tape files, they represent the consolidation of all available data on student naval aviators for those training years. Although Rowland & Company personnel used these data as described above, they have not been completely exploited. This exploitation was intended to be done by the Aerospace Medical Research Laboratory research personnel.

TRAINING SYSTEM ANALYSIS

The above data which were placed into the Experimental Data Bank offered an opportunity for examination in certain combinations so as to provide quantitative information about certain features of the training system from which they were secured. These features included the following: (1) student attrition statistics; (2) student stage graduate quality profiles;

(3) student stage flight-hour distributions; (4) student throughput-days to complete individual stages and phases of their flight training; and (5) student quality control mechanisms. Each of these features are summarized below.

Student Attrition Statistics

Of what value are statistics on student attrition? The primary value is that these data identify the stage, the hop and the specific syllabus maneuver where either a large group of students lacks the aptitudes and skills to handle and therefore fails, or where the training system is ineffective in adapting its instructional techniques to the training needs of the students. Any attempt to cope with the student attrition situation must come to grips with these syllabus situations as revealed by the statistics. These statistics appear in the first three annual reports (references 1, 2, and 3) and no attempt will be made to tabulate them here.

Student Stage Graduate Quality Profiles

Although the flight attrition statistics reveal information about those students who fail the syllabus, grade profiles of student stage graduates demonstrate the performance or skill level achieved by those who are graduated by the training system. These profiles can reveal those stage maneuvers where students have the lowest, average, and the highest proficiency.

Again, those who are concerned with improving either the quality of the student graduates or the quality of the training system effectiveness would find these profiles to be a basic point of departure. These are presented in references 2, 3 and 4.

Student Stage Flight-Hour Distributions

Students enter the training system with wide ranges in aptitudes. Throughout their training, they reveal continued diversity on nearly all available measures. This diversity was found to exist on the number of flight hours each student was given so as to qualify them for stage proficiency. Flight hours data are reported in references 3 and 4.

An interpretation of these data was offered on page 3-29 of reference 3. The data were interpreted as evidence for the existence of a 'differential student learning rate of flight skills.' It could also be interpreted to mean that flight instructors adjusted the hop duration to the needs of the student. The students with the lower grades were given longer flight hops than students in either the medium or high grade groups.

Throughput Days

One possible measure of the effectiveness of a training system is the number of days it requires to train an individual student. For a group of students this may mean an average of throughput days.

The student data placed into the Experimental Data Bank offered an opportunity to collect statistics on student throughput time. Computations were made on one flight-stage in the advanced phase of training and also on the total advanced phase. These data are reported in the Phase IV annual report (4).

The point made in this report is that such computations can be secured from existing student record data and that the use of throughput days should be of interest to management level administrators who are concerned with measures of training system effectiveness and with means for improving existing training systems. Knowing that there is a large diversity among student throughput days may be one piece of interesting information. What is more important to pursue are the reasons for the diversity. This topic was covered in considerable detail in the record concept and content of the Student Management System (Section V of this report).

Quality Control

The grade system is used to help achieve quality control of the students who pass each flight stage in their training. An examination of the student flight attrition statistics reveals that a very very small percentage are failed due to low flight grades per se. The great majority are failed by the 'down' system. It would appear, therefore, that at the low end of the student grade scale the down system is the most used technique to assure a minimum acceptable student quality level. This latter finding was reported and discussed in reference 2.

A corollary observation was also reported in that reference. It observed that a student naval aviator who flew approximately 220 hops may have been instructed and evaluated by as many as 90 separate flight instructors by the time he completed the operational phase of training. One can interpret these data to mean that the student was man-rated repeatedly for his satisfactory performance by each of the 90 instructors. This repeated man-rated system has probably contributed significantly to the knowledge and belief that the final student product can be expected to perform both satisfactorily and reliably (2, p.4-41).

STUDENT SUCCESS PREDICTION

A third subject area of the support tasks is student success prediction. It will be recalled that the Naval Aerospace Medical Research Laboratory has a support role to the Chief of Naval Air Training to provide prediction estimates on students who are in the training program. This includes students who are being trained as naval aviators and those who are being trained for naval flight officer billets. The naval flight officers serve as radar intercept officers on fighter type aircraft, as navigator-equipment operators on reconnaissance aircraft, as Tactical Command officers aboard anti-submarine aircraft, etc.

The Student Success Prediction System was developed and is operated by NAMRL. NAMRL provides scores to squadron training personnel on students whom the squadron wishes to review because these students are encountering some difficulty with the training syllabus. The scores reveal the students' chances of completing the total syllabus successfully. Such scores are computed for about 24 syllabus places in the primary and basic phases of the training syllabus.

The actual value of the score is influenced by various factors. These include the grades a student made on a battery of selection tests, grades

made on entrance tests into officer candidate training, grades made on academic subjects taken in the officer training, and by grades made in the ground school and flight syllabus of the flight training syllabus.

The thrust of the Rowland & Company effort was to identify new kinds of existing but not being used student aptitude and training performance data. In addition, a considerable amount of effort was devoted to the identification of alternative ways of computing flight proficiency grades which could be used in the development of predictive equations. The results of these efforts are reported in references 3 and 4.

The results reported contained: (1) new aptitude measures; (2) the use of cumulative stage hop grade values; (3) the use of a grade that was more sensitive to the flight syllabus maneuvers on which students actually failed; (4) the use of a grade that discriminated more levels of maneuver skills among students than the current grade computation method; and (5) the use of a student flight performance reliability (consistency) score. Some 55 places in the total training syllabus were identified where these other performance measures could be applied and tested for their predictive utility (12).

The student data from which all of these measures could be secured were placed into the Experimental Data Bank and the taped files delivered to the customer.

SECTION VII

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